

Body of ♂ about 31 mm. in length; antennae spotted. The outer extremities of the subgenital plate bent upward and inward and produced into sharp points *herbardi* sp. nov.

Vertex of the head rounded, no thorn.

Body of ♂ about 25 mm. in length; antennae spotted. *rehni* sp. nov.

THE NUMBER OF MOULTS OF THE PEAR-SLUG, *CALIROA CERASI* LINNÉ.

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In the course of some experiments with the pear-slug, *Caliroa cerasi* Linné, in the insectary of the Iowa Agricultural Experiment Station at Ames, considerable interesting data on the moults was obtained. A brief account of this work in general has already been given by the writer (1911). It seems well, however, to give the whole in detail here, as a study of the moults and head widths of this particular insect. The notes were made during the summers of 1909 and 1910; in 1909 by the writer, in 1910 by Mr. T. M. McCall and the writer.

A short account of the life history of this insect follows.

The larva is a dark, almost black, slimy slug, about $\frac{2}{3}$ of an inch long when full grown, which feeds on cherry, pear and plum leaves. These slugs feed on the upper side of the leaves, eating out all the tissue except the veins and the lower surface. The injured leaves become dry and brown and fall from the trees, which are sometimes left entirely bare of foliage in midsummer. The slugs appear twice during the year in central Iowa, the first brood coming on about the middle of June, the second about the third week in July. The insect winters in the larval stage in the ground.

Harris (1841) said that the larvæ moulted five times, Dyar (1895) said that there were six stages (five moults to maturity), and also gave some measurements of the head widths. Marlatt (1897) in his account of the insect said that there were five moults. So there has been no difference of opinion regarding this essential point. However, the measurements which follow will show that considerable

variation may occur, at least under ordinary insectary conditions, although five moults (six stages) is no doubt normal.

Single larvæ were isolated in glass battery jars in the insectary and fed on cherry leaves. A small cherry twig was placed in a bottle of water in each jar. Since there was no danger of the slugs escaping from the jars, these were usually left open at the top, although sometimes covered with netting. Observations were made daily on these cages, all moults recorded, and the cast head measured in every case. In moulting this species leaves the head intact, not splitting it down the middle, as do some saw-fly larvæ. It is the habit of the larvæ to eat their cast skins, although the head itself it not eaten, but remains on the leaf. By cutting out a small piece of leaf together with the cast head, this could be placed on a microscope stage and the head easily measured. The measurements were made with an ocular micrometer, used with a Leitz compound microscope, No. 3 objective, No. 2 ocular.

In the accompanying table of head widths of individual larvæ all the available data were used, whether or not a larva became full grown. Consequently a part of the records are incomplete, but all the figures given here were used in computing the average head width for the several stages. Each vertical column in the table represents a single larva, and each figure a separate and distinct moult.

It will be noticed that where complete records are given, larvæ moulted from five to eight times. Of these, five larvæ moulted 5 times, five 6 times, three 7 times and 1 larva moulted 8 times.

Considering first those larvæ that moulted five times it may be noticed that with only two of these the head width increased regularly in anything like a geometrical proportion. These are the larvæ in cages 53/09 and 214/10. In general the head width of a larva increases at some definite geometrical ratio with each stage, a fact to which Dr. Dyar (1890) has already called attention. In the case of the pear-slug the ratio of increase is practically .35.

In the other three cases there has been a slip in the progression. In cage 70/09 stage IV seems to have been missed entirely, for the width .72 mm. is hardly enough to give it a place in that stage. In cage 421/10 stage IV is clearly missing, even though there are five moults. Here the larva moulted twice, and the cast head measured .65 mm. each time. When it next moulted the head was 1.08 mm.

wide, clearly belonging to stage V. Again in cage 193/10 stage I moulted twice with a bare increase in width, while there is no measurement which fits stage IV.

MEASUREMENTS OF HEAD WIDTHS, 1909-1910.

Exp.	51/09	52/09	53/09	56/09	61/09	70/09	72/09	75/09	77/09	102/10	103/10	104/10	109/10	214/10	229/10
I			.36		.36	.36	.32	.36	.36	.39	.36	.36	.32	.39	.32
II	.54		.50	.54	.54	.54			.50	.50	.54	.50	.47	.54	.43
	.54												.54	.54	.54
III		.68	.68	.68		.65			.61	.65	.72	.68		.65	.72
						.72									
IV	.79	.79	.79	.75					.79	.87				.90	.90
V	.98	1.01	1.01	.98		.98					.94			1.01	1.08
No. of moults			5			5					5			5	6

Exp.	230/10	240/10	246/10	247/10	253/10	402/10	403/10	421/10	422/10	423/10	427/10	428/10	429/10	439/10	452/10
I	.32	.32	.32	.32	.36	.32	.32	.36	.32	.32	.29	.32	.32	.32	.32
				.36	.36		.39			.36	.36			.39	.39
II	.43	.43	.43		.50	.47		.50	.50	.58	.58	.47	.43	.54	
		.54	.58			.47						.58	.58		
III	.61	.65	.72	.68	.65	.68		.65			.68	.65	.72	.61	
	.72							.65						.65	
IV	.87	.87	.90		.87	.83					.90		.83	.79	
					.90									.90	
V	1.08	1.08	1.01		1.05	1.05		1.08			1.16	1.01		.98	
			1.08		1.16							1.08			
No. of moults	6	6	7		7	7		5			6	6		8	

Among those larvæ that moulted six times similar irregularities may be noticed in nearly every stage. The increase is often very slight, too much so to be considered as a separate stage.

With the larvæ that moulted seven times there are two cases where two successive moults fail to show any increase whatever. The other extra moults are close together.

In the case of the single larva that moulted eight times there was a very slight increase every time, no two measurements being exactly the same. But here also the figures fall rather well into the five stages, as they are given in the table.

The following table shows the variation under the several stages. The figures at the right of each measurement indicate the number of times that measurement occurred.

Stage I.		Stage II.		Stage III.		Stage IV.		Stage V.	
Mm.		Mm.		Mm.		Mm.		Mm.	
.29	1	.43	5	.61	3	.75	1	.94	1
.32	15	.47	4	.65	9	.79	5	.98	4
.36	13	.50	7	.68	7	.83	2	1.01	5
.39	6	.54	11	.72	6	.87	4	1.05	2
		.58	5			.90	6	1.08	6
								1.16	2

This represents a great variation. In fact every space on the ocular micrometer scale between .29 mm. and 1.16 mm. is shown in the table.

From the figures in the two tables there are two things which stand out clearly: the fact of the variation in the number of moults, and the fact that a larva may moult, and yet not increase in size, or with very little increase.

Considering first the matter of variation it may be shown that this may be reduced to some order. I have said that the ratio of increase of the head widths was practically .35. The average measurements, made as given in the large table, are here compared to the theoretical figures at that ratio.

	Average.	Theoretical.
Stage I	.35	.35
II	.51	.47
III	.67	.63
IV	.85	.85
V	1.04	1.14
VI	1.13	1.14

In giving the average for stage VI measurements not included in the table are used. The average was made from a separate set of larvæ. Stages V and VI may be compared to one figure in the theoretical column, since in the ultimate stage of certain saw-fly larvæ (in which the larvæ do not feed) the head width is practically the same as in the stage preceding it. In using the term "ultimate" I am following Dyar (1896). In this ultimate stage the larva is orange in color, and clean and dry of all slime. These orange larvæ enter the soil soon after moulting and are seldom seen.

Doctor Dyar (1895) has recorded some measurements for the head widths of the stages. These are: I, .25 (?) (not measured);

II, .35; III, .55; IV, .8; V, 1.1 and VI, 1.1 mm. Comparing these with the average measurements just given it is evident that Dyar missed one stage, stage III, while the figure suggested for stage I is much too low. The figures for stages II and III are equivalent to those for stages I and II in our averages. Stage III then is missing in Dyar's figures. The measurements given for stages IV, V and VI are approximately equivalent to our averages.

Taking up the matter of increase in size of the head widths, it is seen that such an increase is by no means constant. The old idea of the moulting process as one merely to allow for the growth of the larva will certainly not hold here, for in many cases little or no growth is recorded after a moult. Dr. O. W. Oestland, of the University of Minnesota, suggested to me that the idea of moulting as an excretory process would fit just such a case as this. Folsom (1906), and probably others also, have suggested an excretory function of the moulting process.

An explanation of the large number of moults, based on the idea suggested in the preceding paragraph, may be found in the somewhat artificial conditions of the insectary cages. Inside the glass battery jars it frequently becomes very hot. The water in the glass bottles which held the cherry twigs probably caused a high humidity also. Such conditions are very different from those outside on a cherry tree, where abundant shade and air currents would keep the temperature and moisture at lower points. It seems quite likely that these artificial conditions had an ill effect on the larvæ, and these, in the endeavor to throw off this effect, moulted more than the normal number of times.

Saunders (1870) found that slugs would moult easily when sand or ashes were thrown over them. He applied sand to some slugs several times, but instead of being harmed by it, they simply moulted, leaving the sand with the old cast skin. Apparently the application of the sand was conducive to the moulting; Saunders said that it occurred several times.

While the growth of the larva is without doubt an important factor in the ecdysis of the pear-slug, it apparently is not the only factor concerned. The fact that there may be moulting without perceptible growth indicates that other reasons have an important bearing in the explanation of moulting. In fact, growth may not even be a primary factor in the true explanation of the moulting process.

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NOTES ON A MISTLETOE ANT.

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While collecting in Miller Canyon, in the Huachuca Mts., Arizona, during November, 1910, my attention was attracted by the very large and beautiful masses of mistletoe (*Phoradendron flavescens* var. *villosum*) growing on the live oaks (*Quercus emoryi*) which in that locality abound at altitudes of 5,000-6,000 feet. I noticed that many of the masses of mistletoe had wilted more or less and had turned yellow. On closer examination I found that their stems at the base, and in many cases for several inches from their point of attachment to the oak branches, had been hollowed out by a beetle larva and that the cavities thus formed were regularly tenanted by colonies of a small black ant (*Crematogaster arizonensis* Wheeler). The worker of this ant was first described from Tucson, Arizona,¹ where I found it to be not uncommon on the trunks of cotton-woods and mesquites in the valley of the Santa Cruz River. In the Huachucas it was not only living in the hollow stems of every yellow mistletoe which I examined—and I broke open dozens of them from many different oaks—but the walls of the cavity were invariably covered with reddish Coccids, which the ants were busily attending. These Coccids, which Prof. T. D. A. Cockerell has kindly identified for me as

¹ "The Ants of Texas, New Mexico and Arizona," Part I, Bull. Amer. Mus. Nat. Hist., XXIV, 1908, p. 482.